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ECO- FRIENDLY SISAL UNION FABRIC – SUITABILITY ASSESMENT

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ABSTRACT

Today's world is increasingly environmentally conscious and natural clothing, lifestyles are advancing. The inclination towards eco-friendly textile alternatives and the emergence of innovative fabrics is vivid. Today's growing concerns are health, sustainability of waste management and environmental awareness which is reflecting on renewed interest in plant fibers. The hunt is on for ecologically friendly fabrics. The movement toward trendy organic fashions and alternative fashion has led to the revival and revision of traditional fibers with natural and organic approaches. New fibers are being developed and are valued for their sustainable and biodegradable characteristics. Sisal fiber offers excellent market potential in terms of its eco-friendly properties as compared with other natural and man-made fibers. For these reasons enzyme treated fiber was processed separately to produce yarns that were used for making treated and untreated fabrics.

KEYWORDS: Life Style, Waste Management, Fabrics & Biodegradable

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Original Article

INTRODUCTION

In recent years sisal has been utilized as a strengthening agent to replace asbestos and fiberglass and is increasingly a component used in the automobile industry, where its strength, "naturalness" and environmentally friendly characteristics are greatly appreciated. The innovative approaches towards sisal fiber technologies will address burning issues like wasteland utilization, development of non-farm sector, employment generation in rural and semi-urban areas, green technologies and bio-renewable materials production for environmental conservation.

Need for textiles and ready-made garments is continuously increasing in India with an increase in population and spending power. Preference of eco-friendly fabric over synthetic fabric in hot, humid tropical and subtropical climate helps in boosting the demand for Sisal fiber. However, the use of sisal fiber for commercial production is still to gear up in India. Sisal fiber offers outstanding potential in terms of its eco- friendly properties as compared to other natural and man-made fiber. Improvement in characteristics of sisal fiber with pretreatment will increase the worth of the fiber and creates demand for sisal fiber. The farmers on the other hand will be benefited through the extraction and sale of the fiber from agricultural waste

MATERIAL & METHODS

Processing of the Fiber as Weft

Raw sisal fiber was processed separately to get yarns that were used for control fabrics. Enzymes related fiber was processed separately to produce treated yarns that were referred to as treated fabrics.

Enzymatic Softening of Sisal Fiber

Optimization of Enzyme Concentration

To standardize the softening treatments on sisal fiber, three varieties of enzymes, namely Microsil, Sibosof, New smooth with three different concentrations of 0.5 percent, 1.5 percent, 2 percent were selected for each enzyme based on the minimum and maximum recommended levels of enzyme concentration by the manufacturing company, Britacel, Mumbai. 100 grams of fiberfrom the fine selected variety was weighed and used for enzyme treatment. Based on the weight of fiber the enzyme requirement was calculated for providing the concentration of 0.5 percent, 1.5percent, and 2 percent. The M: L ratio of 1:30 was maintained. The recommended pH 5 for the application of each enzyme was maintained. Fiber was placed in the solution under continuous rotation for 30 minutes. Later it was rinsed, dried in shade condition and subjected to tensile performance.

Assessment of Physical Properties of Enzyme Treated Sisal Fiber

The enzyme treated sisal fibers were subjected to physical testing to determine the quality parameters which play a major role in the evaluation of the quality of the fabric.

Fiber Tenacity (g/Tex) and Elongation (%)

The maximum load (force) suggested by the specimen in a tensile test carried out to rupture is the breaking load or the tensile strength of the fiber. The breaking strength of the fiber determined is usually taken as an index of fiber quality and is expressed either in grams or pounds. The specimens of 10cm length were tested with the speed of 100mm/ min, 100mm gauge length and with 10kgs specific load range under standard atmospheric conditions in DAK systems tensile testing machine in College of Home Science, Hyderabad.

The value of reading for elongation at break was simultaneously recorded and expressed in terms of percentage. Based on the quality parameters like strength, elongation at break, peak load and smoothness of the treated fiber one best concentration should be selected from each enzyme.

Enzyme Treatment on Fiber

The standardization of softening treatments on sisal fiber was carried out with different enzyme concentrations and the enzyme treated sisal fiber was subjected to tensile strength testing. Based on the tensile performance of the fiber, the three enzymes new smooth, Microsil and Sibasof were used in 2, 1.5 and 0.5 percent respectively.

Table 1: Parameters and Operational Ranges of Enzymes

Parameters	Operational Range
Temperature	Room temperature
pH	5
Time	30 minutes
Concentration	New smooth-2%, Microsil-1.5%, Sibasof- 0.5%
M: L ratio	1:30

Enzyme treatment was carried out in a specially designed container; the fiber was steeped in water with M: L of 1:30 ratio and the pH was maintained at 5. The enzyme was added as required to the prepared liquor and the fiber was left in the solution for 30 min. Then the fiber was rinsed and dried. The fiber thus, finished was winded manually.

Weavers Twisting of Sisal Fiber

Sisal fiber obtained from enzyme treatments, were made into continuous yarn by weavers twisting process. A weaver twisting is a process in which the fibers are fused together to form a continuous length fiber with the required twist, as shown in figure 1 and was therefore given at a Southern groups handloom unit, Malikipuram (Rajahmundry). Thus the obtained winded fiber is introduced onto the bobbins and inserted into the shuttle case, and further weaving was done according to the required woven structure

Figure 1: Weavers Twisting of Sisal Fiber

Weaving of the Fabric

Weaving is one of the processes of fabric manufacturing where two sets of yarns *i.e.*, warp end and the filling yarn/ weft are interlaced at right angles to each other, according to a prearranged design. In the present study, three different types of union fabrics for each enzyme were woven on a handloom using cotton as warp with the yarn count of the 60s and 40s of treated sisal fiber as weft. The control sample was woven using cotton as warp and untreated sisal fiber as weft. The following flowchart provides the better understanding of fabric formation.

Flow Chart

Sisal Fibre

⇩

Softening of Fibre

⇩

Weavers Twisting

⇩

Weaving

Table 2: Loom Particulars of Sisal Union Fabrics

S. No	Particulars	Union Fabrics
1.	Type of loom	Handloom
2.	Reed count	80’s
3.	Reed width	72"
4.	Cloth width	41"
5.	Denting order	2 threads /inch

Selection of Weaving Center

For the present study Southern groups, Malikipuram (Rajahmundry) was selected as it is the only known weaving center in Andhra Pradesh to make weaver’s twisting. The sisal union fabrics with cotton warp and sisal fiber as weft with required variations in weft were woven on a loom by the weavers as shown in figure 2 and 3


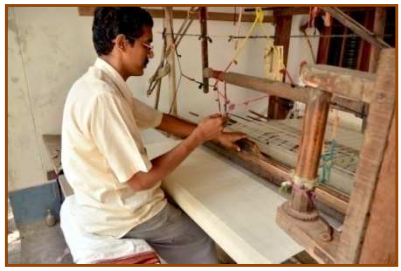

Figure 2: Weaving of Sisal Union Fabrics on Handloom

Figure 3(a): Control samples

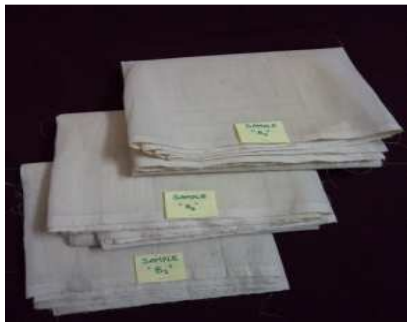

Figure 3(b):Enzyme I Treated Samples

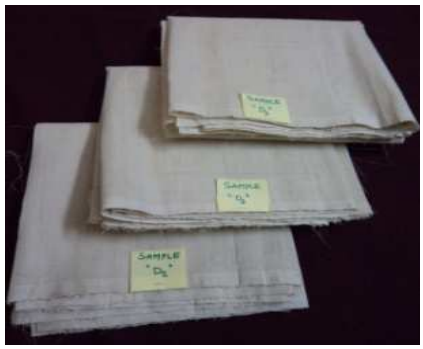

Figure 3(c):Enzyme II Treated Samples

Figure 3(d):Enzyme III Treated Samples

Figure 3: Designed Eco-Friendly Sisal Union Fabric

SUBJECTIVE EVALUATION

Subjective evaluation was undertaken to assess the consumer opinion and preferences regarding the eco-friendly finishing of the fabric. A panel of 30 judges comprising of staff, customers, Weavers Service Centre and students of the College of Home science, Hyderabad was selected for evaluation. A schedule was developed for the judges evaluated the treated fabric and gave their opinion based on color, lustre, thickness, texture, stiffness, and drape in comparison with the untreated fabric as per schedule

RESULTS

It was desirable to soften the fiber to improve its pliability required for better weavers twisting of yarn. Accordingly, the fiber was treated with eco-friendly enzyme and then blended with cotton in three ratios. The types of treated and untreated fabrics were developed also assessed the suitability of the fabrics through subjective evaluation. For the purpose of convenience the fabrics are labeled, the details were furnished below:

Enzyme – I: New smooth – 2 percent concentration

Enzyme –II: Microsil – 1.5 percent concentration

Enzyme –III: Sibasof - 0.5 percent concentration

Table : 3

Control	Enzyme -I (2%)	Enzyme -II (1.5%)	Enzyme -III (0.5%)
A_1– 100% sisal	B_1 – 100% sisal	C_1 – 100% sisal	D_1– 100% sisal
A_2– 50% sisal50% cotton	B_2 – 50% sisal50% cotton	C_2 – 50% sisal50% cotton	D_2 – 50% sisal50% cotton
A_3 – 25% sisal75% cotton	B_3 – 25% sisal75% cotton	C_3 – 25% sisal75% cotton	D_3 – 25% sisal75% cotton

Subjective Evaluation

Table 4: Texture of the Fabric

Sample	Source	Smooth		Slightly Smooth		Slightly Rough		Rough	
		No. R	%	No. R	%	No. R	%	No. R	%
100%	Control	4	13.33	3	10	15	50	8	26.66
	Enzyme 1	20	66.66	7	23.33	3	10	0	0
	Enzyme 2	15	50	10	33.33	0	0	5	16.66
	Enzyme 3	12	40	14	46.66	4	13.33	0	0
50% 50%	Control	5	16.66	10	33.33	8	26.66	7	23.33
	Enzyme 1	25	83.33	5	16.66	0	0	0	0
	Enzyme 2	14	46.66	7	23.33	6	20	3	10
	Enzyme 3	4	13.33	16	53.33	8	26.66	2	6.66
25%-75%	Control	6	20	1	3.33	23	76.66	0	0
	Enzyme 1	2	6.66	28	93.33	0	0	0	0
	Enzyme 2	10	33.33	15	50	5	16.66	0	0
	Enzyme 3	3	10	17	56.66	5	16.66	5	16.66

No. R - No. of respondents, % - Percentage

The majority of the respondents rated that the texture of the fabric changed after treatment. Enzyme I treated fabrics 100% and 50%-50% showed improved smoothness. As per fabric 25%-75%, the majority of the respondents felt that the control was slightly rough, but after the treatment, the fabrics improved in their texture, as evident from acquired data.

Table 5: Lustre of the Fabric

Sample	Source	Bright		Medium		Dull	
		No. R	%	No. R	%	No. R	%
100%	Control	4	13.33	15	50	11	36.66
	Enzyme 1	6	20	18	60	6	20
	Enzyme 2	3	10	17	56.66	10	33.33
	Enzyme 3	8	26.66	11	36.66	11	36.66
50% 50%	Control	7	23.33	13	43.33	10	33.33
	Enzyme 1	12	40	18	60	0	0
	Enzyme 2	9	30	15	50	6	20
	Enzyme 3	2	6.66	18	60	10	33.33
Table 5: Contd.,							
25%-75%	Control	4	13.33	8	26.66	18	60
	Enzyme 1	0	0	28	93.33	2	6.66
	Enzyme 2	3	10	17	56.66	10	33.33
	Enzyme 3	0	0	19	63.33	11	36.66

No. R - No. of respondents, % - Percentage

It was apparent from the above table that the lustre of the fabric changed after enzyme treatment. The brightness of fabric 50%-50% improved from dull to medium and rated as a medium with enzyme I. The brightness of the fabric were improved from medium to bright for fabric 25%-75% after treatment with enzyme I. The change of brightness is rated low for fabric 100%. Hence it was concluded that the treated fabric 50%-50% had more luster followed by fabric 25%-75%.

Table 6: Stiffness of the Fabric

Sample	Source	Very good		Good		Medium		Limpy	
		No. R	%	No. R	%	No. R	%	No. R	%
100%	Control	0	0	15	50	11	36.66	4	13.33
	Enzyme 1	0	0	13	43.33	14	46.66	5	16.66
	Enzyme 2	0	0	14	46.66	16	53.33	0	0
	Enzyme 3	0	0	18	60	12	40	0	0
50% 50%	Control	0	0	22	73.33	8	26.66	0	0
	Enzyme 1	0	0	21	70	8	26.66	1	3.33
	Enzyme 2	0	0	20	66.66	7	23.33	3	10
	Enzyme 3	0	0	18	60	12	40	0	0
25%-75%	Control	0	0	12	40	16	53.33	2	6.66
	Enzyme 1	0	0	16	53.33	14	46.66	2	6.66
	Enzyme 2	0	0	18	60	12	40	0	0
	Enzyme 3	0	0	13	43.33	17	56.66	0	0

No. R - No. of respondents, % - Percentage

The data on the stiffness of all fabrics is furnished with table 6. The majority of the respondents felt that the stiffness of the fabric ranged between good to medium. The control Fabric 50%-50% was felt as having good stiffness by a greater number of respondents, followed by enzyme II treated Fabric 50%-50% and enzyme treated fabric 100%. Overall, the enzyme treatment showed a slight change in the stiffness of the fabric.

Table 7: Thickness of the Fabric

Sample	Source	Very thick		Thick		Medium		Thin	
		No. R	%	No. R	%	No. R	%	No. R	%
100%	Control	0	0	12	40	18	60	0	0
	Enzyme 1	0	0	8	26.66	18	60	4	13.33
	Enzyme 2	2	6.66	14	46.66	16	53.33	0	0
	Enzyme 3	0	0	12	40	14	46.66	4	13.33
50%-50%	Control	0	0	12	40	16	53.33	2	6.66
	Enzyme 1	2	6.66	16	53.33	14	46.66	0	0
	Enzyme 2	0	0	18	60	12	40	0	0
	Enzyme 3	2	6.66	14	46.66	16	53.33	0	0
25%-75%	Control	4	13.33	15	50	11	36.66	0	0
	Enzyme 1	0	0	13	43.33	14	46.66	5	16.66
	Enzyme 2	0	0	28	93.33	2	6.66	0	0
	Enzyme 3	0	0	19	63.33	11	36.66	0	0

No. R - No. of respondents, % - Percentage

The data from the table 7 can be inferred as enzyme II treated fabric 25%- 75% were the thickest among all fabrics as expressed by the majority of the respondents. As per Fabric 50%-50% and 25%-75%, the control fabric was categorized as medium and after treatment the fabrics did not exhibit improvement in thickness.

Table 8: Drapability of the Fabric

Sample	Source	High		Medium		Low	
		No. R	%	No. R	%	No. R	%
100%	Control	0	0	5	16.66	25	83.33
	Enzyme1	0	0	23	76.66	7	23.33
	Enzyme 2	0	0	18	60	12	40
	Enzyme 3	0	0	12	40	18	60
50%-50%	Control	0	0	4	13.33	26	86.66
	Enzyme 1	0	0	18	60	12	40
	Enzyme 2	0	0	19	63.33	11	36.66
	Enzyme 3	0	0	21	70	9	30
25%-75%	Control	0	0	14	46.66	16	53.33
	Enzyme 1	0	0	19	63.33	11	36.66
	Enzyme 2	0	0	10	33.33	20	66.66
	Enzyme 3	0	0	13	43.33	17	56.66

No. R - No. of respondents, % - Percentage

Table 8 shows the opinion of the respondents with regard to the drapability of the fabric. Most of the people rated fabric 100% and 50% -50% to have low drapability in the control stage where as after treatment the drapability of the fabric improved from low to medium. The majority of the respondents felt that fabric 25% -75% with treatment II has improved drapability after treatment. This might be due to improved handling properties after the treatment.

Table 9: Suitability of the Fabric

Samples		As Shirting Material			As Dress Material			As Furnishing Material		
		Suitable	Fairly Suitable	Un Suitable	Suitable	Fairly Suitable	Un Suitable	Suitable	Fairly Suitable	Un Suitable
		No.R	No.R	No.R	No.R	No.R	No.R	No.R	No.R	No.R
Sample 100%	Control	2(6.6)	10 (33.3)	18 (60)	0 (0)	0 (0)	30 (100)	12 (40)	10 (33.3)	8 (26.6)
	Enzyme I	11(36.6)	9 (30)	10 (33.3)	0 (0)	7 (23.3)	23 (76.6)	15 (50)	14 (46.6)	1 (3.3)
	Enzyme II	6(20)	20 (66.6)	4 (13.3)	0 (0)	5 (16.6)	25 (83.3)	12 (40)	10 (33.3)	8 (26.6)
	Enzyme III	9(30)	10 (33.3)	11 (36.6)	0 (0)	6 (20)	24 (80)	14 (46.6)	10 (33.3)	6 (20)
Sample 50%-50%	control	7(23.3)	23 (76.6)	0 (0)	9 (30)	11 (36.6)	10 (33.3)	18 (60)	12 (40)	0 (0)
	Enzyme I	15(50)	5 (16.6)	0 (0)	2 (6.6)	12 (40)	16 (53.3)	26 (86.6)	3 (10)	1 (3.3)
	Enzyme II	10(33.3)	2 (6.6)	18 (60)	0 (0)	10 (33.3)	20 (66.6)	22 (73.3)	8 (26.7)	0 (0)
	Enzyme III	13(43.3)	15 (50)	2 (6.6)	0 (0)	12 (40)	18 (60)	12 (40)	14 (46.6)	4 (13.3)
Sample 25%-75%	control	0(0)	4 (13.3)	26 (86.6)	0 (0)	2 (6.6)	28 (93.3)	6 (20)	14 (46.6)	10 (33.3)
	Enzyme I	11(36.6)	18 (60)	1 (3.30	8 (26.6)	18 (60)	4 (13.3)	18 (60)	10 (33.3)	2 (6.6)
	Enzyme II	7(23.3)	10 (33.3)	13 (43.3)	0 (0)	4 (13.3)	26 (86.6)	9 (30)	10 (33.3)	11 (36.6)
	Enzyme III	9(30)	12(40)	9(30)	4(13.3)	10 (33.3)	16 (53.3)	15 (50)	20 (66.6)	5 (16.6)

No. R - No. of respondents, (Values in parenthesis indicate percentages)

The majority of the respondents rated Enzyme I treated sample, 50%- 50% as the best choice among the samples as shirting material followed by enzyme I treated sample 100%. Enzyme I treated sample, 50% -50% was preferred to other samples for furnishing followed by enzyme II treated sample 50% -50%. Among the samples, Enzyme I treated sample, 25% -75% (60%) was graded as fairly suitable for dress material. No other fabric was considered suitable for dress material which could be attributed to the weaving structure of the fabrics.

CONCLUSIONS

Subjective evaluation of aesthetic and handle of fabrics revealed that treated sisal union fabrics were better than the untreated fabrics. According to the preferences of respondents, it was clear that all the fabrics were accepted, with enzymatic softening treatment. The results of the study indicated that developed sisal union fabrics improve on their apparel oriented properties such as the handle, aesthetic, etc. Hence, the results of the study can be adopted by the textile industry that produces apparel fabrics at both cottage and industrial level.

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